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PATENT- OG VAREMÆRKESTYRELSEN

A liquid fuel supply unit for a liquid fuel burner and a liquid fuel burner system.

The present invention relates to a liquid fuel supply unit for a liquid fuel burner and a liquid fuel burner system. Especially the invention relates to domestic heating the liquid fuel burner having a heat output of less than 10 kW.

Liquid fuel burners, such as oil burners, are quite common for domestic use. Ordinarily such oil burners are of the oil pressure atomizing type having high-pressure pumps delivering oil at high pressure. These burners operate on the principle that when oil under pressure is permitted to expand through a small orifice, it tends to break into a spray of very fine droplets, which are suitable for combustion. These burners are usually designed to operate with oil pressure as high as 3 MPa and viscosities of from 2 cSt. The principle upon which these burners operate requires that the pressure drop across the orifice be maintained high and as nearly constant as possible in order to achieve the necessary fine atomized droplets and also to avoid pulsating combustion. Because it is not possible to maintain the required atomization at lower pressure drop and thus lower flow, modulation or regulation of the heat output, in the operation of such burners has traditionally been very severely limited or has not been used at all, and the burners have been operated in an on-off mode only. This results in inferior temperature control, lower boiler efficiency and increased thermal load of the components, as they will experience a lot of heating and cooling cycles. On-off regulation also has a detrimental impact on the environments due to the many start-ups during which the combustion of the fuel not optimal.

The minimum output of the burner is controlled by the size of the holes in the orifice. The smallest

feasible holes are 0,1 mm in diameter, as smaller holes will clog very quickly due to inevitable particles in the oil or due to soot build-up from the combustion, increasing the need for maintenance to an intolerable level. The ordinary minimum output of oil burners having an orifice with the smallest holes possible, is about 10 kW, which exceeds the static demand of an ordinary household.

One such oil burner is known from US patent no. 5,692,680, which discloses a fuel supply unit for an oil burner. This fuel supply unit comprises a pump delivering pressurized fuel to a metering orifice, where the flow rate of fuel delivered can be regulated by regulating the pressure differential to maintain a constant flow independently of the elevation of the burner and the elevation of the tank with respect to the pumping unit. However, it is generally advantageous to have an adjustable flow rate of fuel to the burner, therefore this kind of supply unit is not desirable.

It has also been proposed to use burners in which a liquid fuel is gasified prior to the supply to the burner. These burners, however, require a significant start-up time, as the fuel must be heated to gasification temperature prior to start-up of the burner, and this kind of burners are mainly used for large industrial burners.

It has also been tried to operate liquid fuel burners on foamed liquid fuel. One such burner is disclosed in US patent no. 5,051,090 wherein the liquid fuel is foamed in a foam collection cylinder. This kind of burner is, however, only suited for large industrial burners.

EP-A-0 556 694 discloses a burner system for liquid fuel and provided for easy modulation to compensate for changes in fuel viscosity. The burner system thus comprises a gas atomizing nozzle fed by an air compressor and a fuel pump, the fuel being fed

through a regulator regulating on basis of a pressure difference.

As oil and most other liquid fuels are fossil fuels and hence a scarce resource, care should be taken to exploit the fuel to the utmost.

An object of the invention is to provide a liquid fuel supply unit for a liquid fuel burner to achieve a high modulation capability. Units are preferable as they provide for easy mounting and/or exchange.

A further object is to provide a liquid fuel supply unit for a liquid fuel burner to achieve a low minimum heat output.

A further object is to provide a liquid fuel burner system which when applied to a boiler of a domestic heating system allows substantially continuous, modulate operation at least during the heating season.

This object is in a first aspect of the invention met by a liquid fuel supply unit for a liquid fuel burner, the supply unit comprising a liquid fuel feed pump and a liquid fuel metering pump, said liquid fuel feed pump having an inlet connectable to a liquid fuel conduit from a liquid fuel source, such as an oil tank, and an outlet connected to an inlet of the liquid fuel metering pump, said metering pump having an outlet being connectable to an atomizing nozzle of the liquid fuel burner, wherein the metering pump is a modulatable output pump. Hereby the liquid fuel delivery from the supply unit can be accurately measured out to give precisely the desired quantity of fuel independently of the pressure of the liquid fuel source.

To further increase the efficiency and modulation capability a gas atomizing nozzle is intended and the liquid fuel supply unit comprises an atomizing gas source for the liquid fuel burner. Using a gas atomizing nozzle allows a strong reduction of the

flow of liquid fuel through the nozzle while maintaining atomizing of the fuel, and thus a strong reduction of the heat output, i.e. a high degree of modulation, is allowed compared to using the pressure atomizing nozzles conventionally used in domestic heating systems.

The atomizing gas source could be a compressed air tank, however according to an embodiment the atomizing gas source is a compressor incorporated in the unit and having an inlet end, which is connectable to a low pressure gas reservoir, such as the atmosphere, and an outlet end, which is connectable to an atomizing gas conduit leading atomizing gas to the liquid fuel burner, whereby a steady flow of atomizing gas can be achieved.

The liquid fuel feed pump and the compressor can be driven independently, but a saving and a desired simplification can be achieved in that the unit comprises a common drive shaft for the liquid fuel feed pump and the compressor.

The liquid fuel feed pump and the compressor can be connected to the motor by chains, gears or the like, but according to a very simple configuration, the liquid fuel feed pump and the compressor both comprise a rotary impeller mounted on the common drive shaft.

The fuel metering pump could be any type of pump suitable for supplying a measured quantity of liquid, however according to an embodiment, the fuel metering pump is a piston pump activated by an electro magnet, whereby it is possible to provide a virtually noiseless metering pump, which is an important parameter when the supply unit is to be used in a household.

According to an embodiment, the compressor is a vane pump, which is a very simple and efficient type of pump at a favourable price.

The feed pump may be any suitable feed pump,

and according to an embodiment the feed pump is a gerotor pump, which is a simple and efficient type of pump at a favourable price.

According to a second aspect, the invention relates to a liquid fuel burner system comprising a burner device with a burner nozzle, a fan for supplying combustion air to the burner device, and a liquid fuel supply unit, according to the first aspect of the invention as a constructional and exchangeable unit for supplying liquid fuel to the burner nozzle.

Preferably the burner nozzle is a low pressure gas atomizing nozzle, the liquid fuel supply unit comprising a compressor supplying atomizing gas to the burner nozzle.

The liquid fuel burner system of the invention is in a preferred embodiment for domestic use, and thus the burner device has a heat output of less than 10 kW.

By means of the invention it is possible to operate a burner continuously for an extended time at least during the time of the year and the day when the need for heating is relatively large.

If a gas atomizing nozzle is used, allowing a larger degree of modulation, continuous operation for a more extended time, even most of the heating season, is possible, it being thus possible to achieve a very low capacity, such as 0.5 kg/h, of liquid fuel to the burner nozzle.

In the following, the invention will explained in more detail by means of embodiments and with reference to the accompanying drawing, in which

Fig. 1 is an oblique view of a compressor,

Fig. 2 is an oblique view of a feed pump,

Fig. 3 is a side view of an assembled compressor-pump unit,

Fig. 4 is a cross-section along line IV-IV of the compressor-pump unit in Fig. 3,

Fig. 5 is a section along the line V-V in Fig.

4, and

Fig. 6 is a diagram showing a heating system utilizing the compressor-pump unit.

For purposes of illustration, the present invention is embodied in burner or heating system and a liquid fuel supply unit, such as may be used in pumping a low volume of fuel oil from a tank (not shown) to a burner nozzle in a household boiler.

Thus Fig. 6 shows diagrammatically a heating system with a liquid fuel supply unit 101 comprising a liquid fuel feed pump 102 connected to a metering pump 103 and a compressor 104. The liquid fuel supply unit 101 is described in more detail with reference to Figs. 1-5. Further the heating system comprises a gas atomizing nozzle 105 fed by the supply unit 101, said nozzle 105 being attached to a burner 106, which is supplied with combustion air by a fan 107. The burner 106 is in turn attached to a boiler 108 of the domestic or household heating system. The boiler 108 and the fan 107 may be of any suitable art. The burner 106 and nozzle 105 may also be of a known art, but may also be of an art subject to a co-pending international patent application by the present applicant.

The fuel supply unit 101, the fan 107 the nozzle 105 and the burner 106 together constitute a burner system.

The compressor 104 can be seen in Fig. 1 in partly disassembled state. The compressor 104 is a vane pump having an impeller 2 mounted on a drive shaft 3. The impeller 2 rotates in a housing 4 having an offset pump chamber 5. On rotation of the impeller 2 movable vanes 6 of the impeller 2 follows the inner wall of the pump chamber 5, so that gas, in the present example air, is drawn in through an inlet (not shown), compressed in the pump chamber 5 between the impeller 2, the housing 4 and the vanes 6, and delivered through an outlet (not shown). To function the

compressor 104 must obviously be equipped with some kind of cover covering the pump chamber.

In Fig. 2 the feed pump 102 can be seen in partly disassembled state, as no cover is shown. The feed pump 102 is a gerotor pump (a kind of gear wheel pump known in the art) comprising a rotary impeller or gear wheel 8 mounted on the shaft 3 to be rotated thereby. The gear wheel 8 meshes with an internal toothing in an eccentrically mounted gear ring 9, thereby defining pump chambers of varying size to pump a liquid, in this case fuel oil, from an inlet to an outlet. Fig. 2 also shows the metering pump 103 connected to the feed pump 102. The bearing housing 11 of the feed pump 102 comprises conduits for delivering oil from the feed pump 102 to the metering pump 103 and conduits for the oil delivered from the metering pump 103 to a metered oil outlet 12 in the bearing housing 11. As may be appreciated from Fig. 5 or when comparing Fig. 1 and 2, the feed pump 102 is mounted on the same drive shaft 3 as the compressor 104, so that the housing of the feed pump 102 also act as cover for the compressor 104. The bearing housing 11 of the feed pump 102 further comprises conduits for compressed air from the compressor 104 to an atomizing gas outlet 13 in the bearing housing 11. Between the housing 4 of the compressor 104 and the bearing housing 11 of the feed pump 7, gaskets 14 are provided. The gaskets 14 are preferably made of carbon fibre sheet material to provide low friction bearings for the impeller 2 and sealing of the housing 4 to hinder leakage of compressed air.

The final assembly is the fuel supply unit 101 comprising the compressor 104, the feed pump 102 and a covering 15 of the feed pump 102 can be seen in Fig. 3, which is a side view of the assembly, and also the metering pump 103. The extending end of the shaft 3 can be connected to a motor. The motor may an external component or it may be incorporated in the

liquid fuel supply unit 101.

In the section of Fig. 4, it can be seen that the metering pump 103 is inserted deeply into the bearing housing 11 of the feed pump 102. The metering pump 103 comprises a piston 16 actuated by an electromagnet 17. Oil delivered from the metering pump 103 passes a one-way valve, in this case a ball 18 biased by a spring 19 to close off the discharge opening of the metering pump 103. From the discharge opening of the metering pump 103, the oil enters a conduit 20 and continues to the outlet 12. Oil to the feed pump 102 enters through an inlet 21 and flows through conduits (not shown) to the feed pump 102. Excess oil from the feed pump 102 is directed to an outlet 22 through conduits (not shown) and through a pressure regulating valve 23 ensuring that the oil pressure before the metering pump 103 is maintained at a desired level e.g. 0.5 bar overpressure (1.5 bar absolute pressure). The output of the metering pump 103 can be modulated with a rate of capacity of 1:5 or more between minimum and maximum. The modulation may be performed gradually or stepwise (e.g. two or three stages).

In the section of Fig. 5, it can be seen that the shaft 3 is connected to the impeller 2 of the compressor and to the gear wheel 8 of the feed pump, which gear wheel 8 meshes with an internal toothing of a gear ring 9. The impeller 2 comprises vanes 6 and rotates in the chamber 5 of the housing 4 of the compressor. In the bearing housing 11 of the feed pump, a conduit 24 for oil delivery to the metering pump 103 is formed, whereas excess oil from the pump returns through a conduit 25 to the outlet 22 (see Fig. 4).

An example of a supply unit for a burner of a domestic boiler operates with a feed pump delivering oil for the metering pump at a rate of 20 l/h and at a pressure of 0.5 bar (overpressure). Oil for the

burner is delivered by a metering pump delivering oil at a rate of down to 0.5 l/h at a overpressure of 0.5 bar. The metering pump is a piston pump, in which the piston is activated by an electromagnet, and the piston has a displacement of 2.8 mm^3 per stroke, which at a frequency of 50 Hz gives the above mentioned flow rate. The compressor delivers atomizing air at a rate of 1.3 m^3/h at a pressure of 0.3 bar. With this supply unit it is possible to obtain an output of the burner of less than 10 kW at continuous operation of the burner.

The described compact design of the supply unit as a constructional unit provides for easy assemblage during production of burners and also makes the supply unit ideal for retrofitting on an existing boiler for domestic use, possibly at a change from using gaseous fuel, such as natural gas, to a liquid fuel, such as fuel oil. Further the gathering of components: liquid fuel feed pump, liquid fuel metering pump and possibly a compressor in a unit provides for easy exchange of such unit if necessary.

The invention is not restricted to the use of oil as the liquid fuel, and would work well with other kinds of liquid fuel. Further, the invention is not restricted to the use of air as the atomizing gas, other kinds of gases, e.g. an inert gas, such as nitrogen, or a gaseous fuel, such as propane, could be used if this should be advantageous in the given situation.

P A T E N T C L A I M S

1. A liquid fuel supply unit (101) for a liquid fuel burner (106), the supply unit (101) comprising a liquid fuel feed pump (102) and a liquid fuel metering pump (103), said liquid fuel feed pump (102) having an inlet (21) connectable to a liquid fuel conduit from a liquid fuel source, such as an oil tank, and an outlet connected to an inlet (24) of the liquid fuel metering pump (103), said metering pump (103) having an outlet being connectable to an atomizing nozzle (105) of the liquid fuel burner (106), c h a r a c t e r i z e d in that the metering pump (103) is a modulatable output pump.

2. A supply unit according to claim 1, c h a r a c t e r i z e d in being intended for a gas atomizing nozzle and comprising an atomizing gas source (104) for the liquid fuel burner (106).

3. A supply unit according to claim 2, c h a r a c t e r i z e d in that the atomizing gas source is a compressor (104) incorporated in the unit and having an inlet, which is connectable to a low pressure gas reservoir, such as the atmosphere, and an outlet, which is connectable to an atomizing gas conduit leading atomizing gas to the atomizing nozzle (105) of the liquid fuel burner (106).

4. A supply unit according to claim 3, c h a r a c t e r i z e d in that the unit comprise a common drive shaft (3) for the liquid fuel feed pump (102) and the compressor (104).

5. A supply unit according to claim 4, c h a r a c t e r i z e d in that the liquid fuel feed pump (102) and the compressor (104) both comprise a rotary impeller (8; 2) mounted on the common drive shaft (3).

6. A supply unit according to any of the claims 1-5, c h a r a c t e r i z e d in that the liquid fuel metering pump (103) is a piston pump activated by an electro magnet (17).

7. A supply unit according to one of the claims 2-6, c h a r a c t e r i z e d in that the compressor (104) is a vane pump.

8. A supply unit according to one of the claims 1-7, c h a r a c t e r i z e d in that the liquid fuel feed pump (102) is a gerotor pump.

9. A supply unit according to one of the claims 1-8, c h a r a c t e r i z e d in that a motor is incorporated.

10. A supply unit according to claim 4 and 9, c h a r a c t e r i z e d in that the motor is connected to the common drive shaft (3).

11. A liquid fuel burner system comprising a burner device (106) with a burner nozzle (105), a fan (107) for supplying combustion air to the burner device (106), and a liquid fuel supply unit (101) according to claim 1 as a constructional and exchangeable unit for supplying liquid fuel to the burner nozzle (105).

12. A liquid fuel burner system according to claim 11, c h a r a c t e r i z e d in that the burner nozzle (105) is a low pressure gas atomizing nozzle, the liquid fuel supply unit comprising a compressor (104) supplying atomizing gas to the burner nozzle (105).

13. A liquid fuel burner system according to any of claim 11 or 12, c h a r a c t e r i z e d in that the burner device (106) has a heat output of less than 10 kW.

A B S T R A C T

A liquid fuel burner system and a liquid fuel supply unit (101) for the liquid fuel burner (106) of the system are disclosed. The supply unit (101) comprises a liquid fuel feed pump (102) and a liquid fuel metering pump (103), the liquid fuel feed pump (102) being connectable to a liquid fuel conduit from a liquid fuel source, such as an oil tank. An outlet of the feed pump (102) is connected to an inlet of the liquid fuel metering pump (103), which in turn is connectable to an atomizing nozzle (105) of the liquid fuel burner (106). The metering pump (103) is a modulatable output pump.

(Fig. 6)

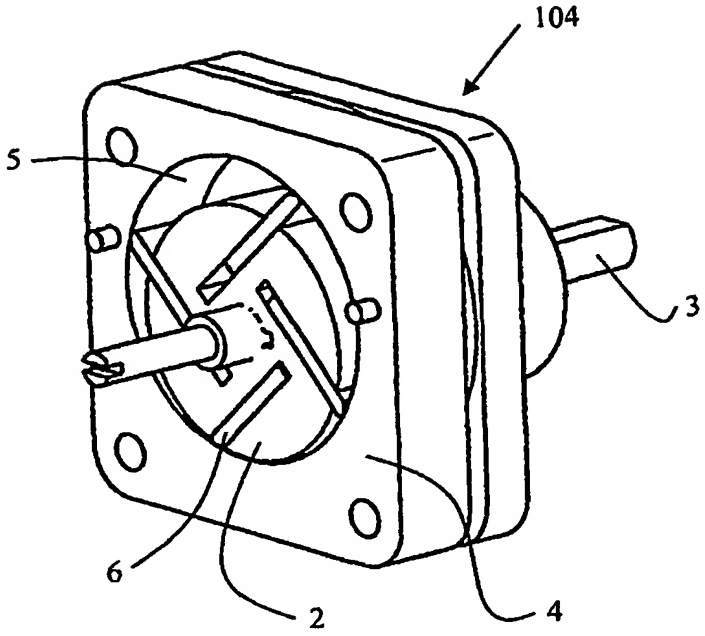

Fig. 1

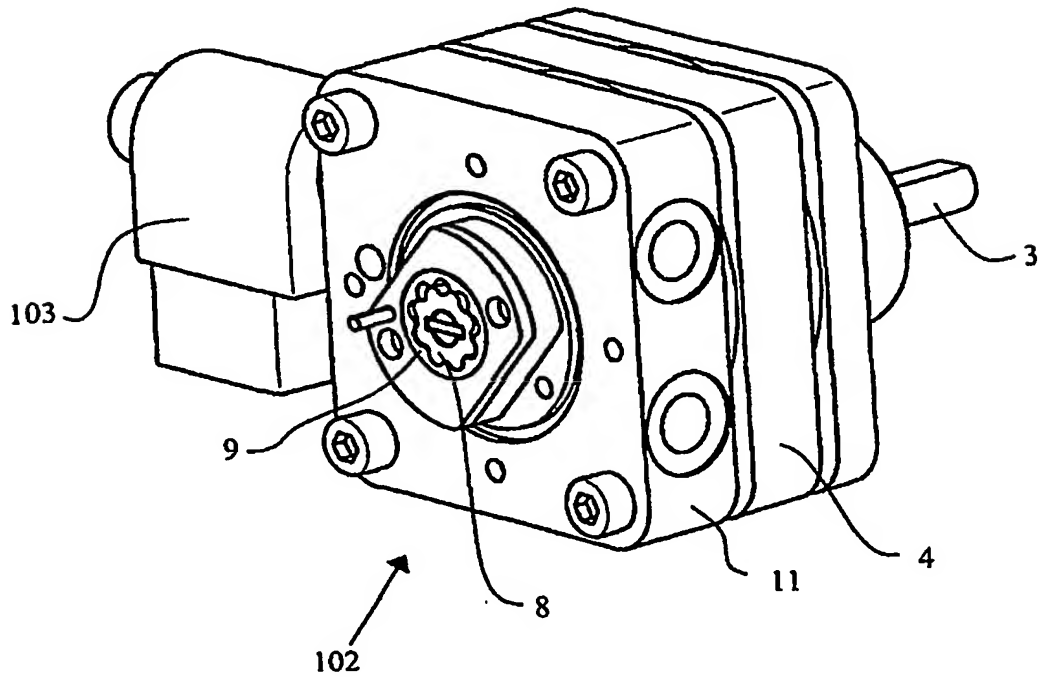

Fig. 2

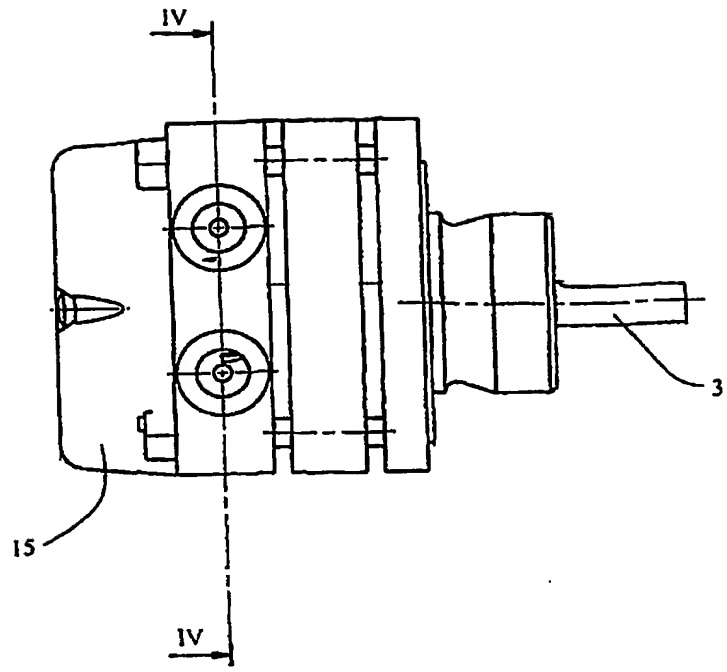

Fig. 3

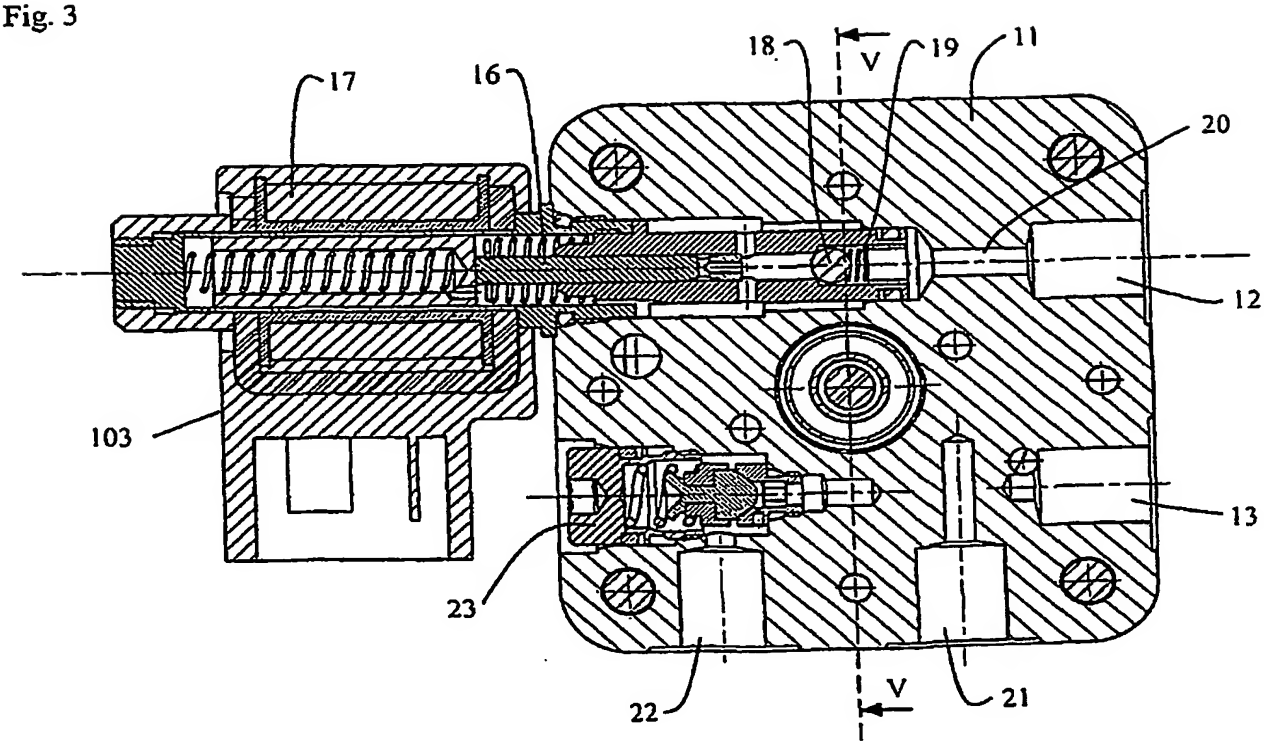

Fig. 4

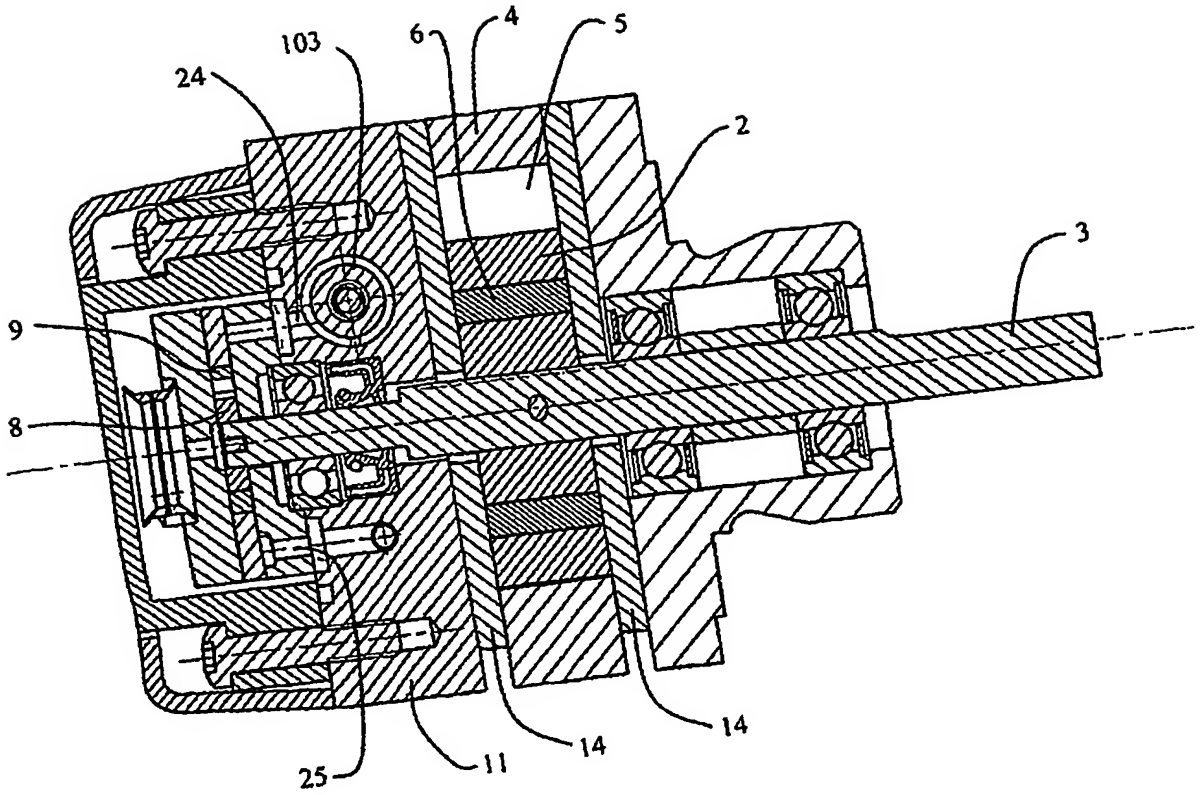

Fig. 5

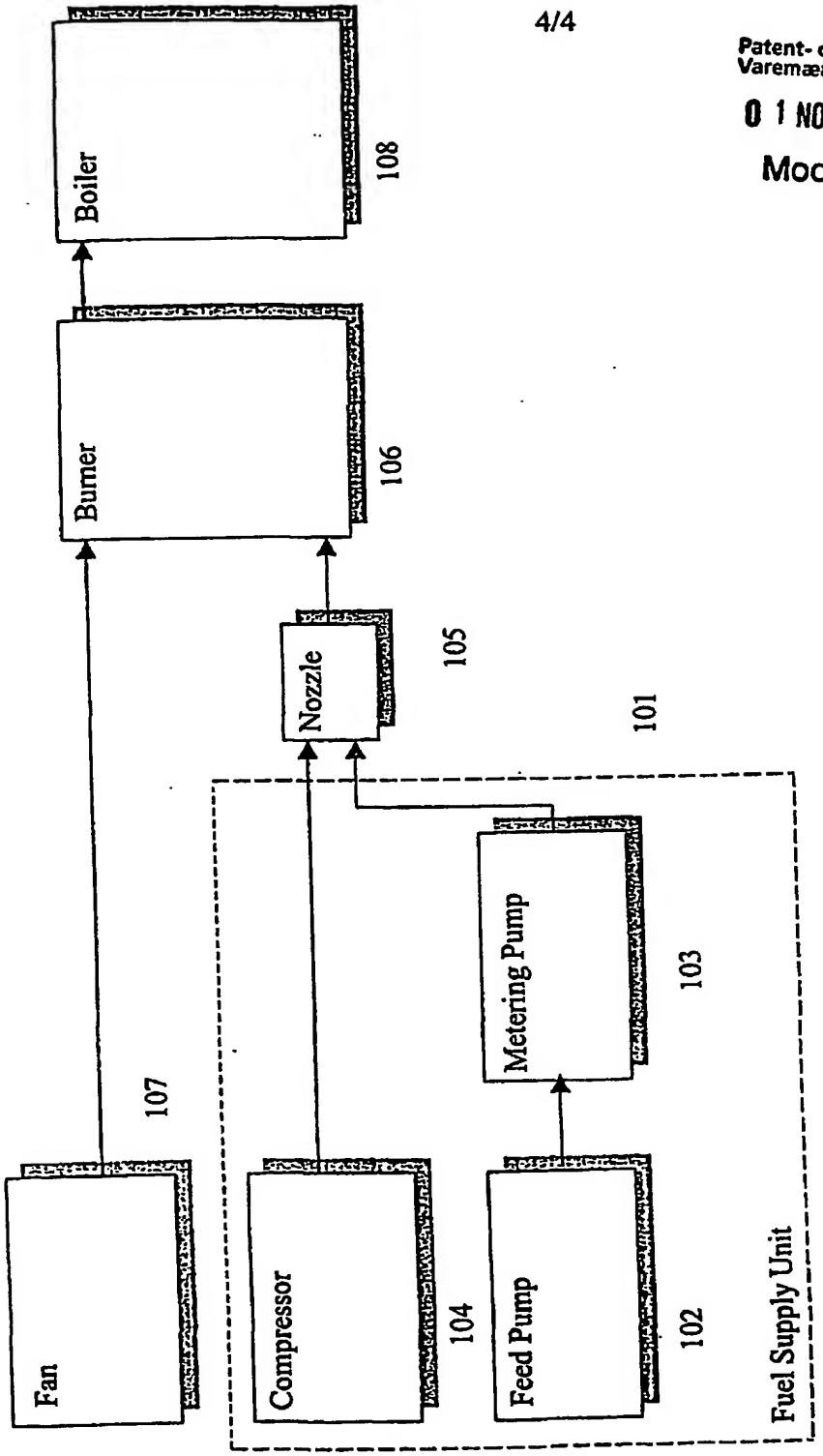

Fig. 6